KUNGL. SVENSKA VETENSKAPSAKADEMIENS HANDLINGAR. Band 47. N:o 1.

PRIAPULIDS AND SIPUNCULIDS

DREDGED BY THE

SWEDISH ANTARCTIC EXPEDITION

1901–1903

AND

THE PHENOMENON OF BIPOLARITY

BY

HJALMAR THÉEL

WITH FIVE PLATES AND EIGHT ILLUSTRATIONS IN THE TEXT

READ JUNE 7TH, 1911

UPPSALA & STOCKHOLM
ALMQVIST & WIKSELLS BOKTRYCKERI-A.-B.
1911

The material at my disposal is not very comprehensive oving to the unfortunate event that the »Antarctic» was wrecked by the drift ice. The steamer sunk with as great part of the collections in the neighbourhood of Paulet Island. Nevertheless, the residue of the collections, which fortunately had been deposited in the Falkland Islands before the catastrophe, is comprehensive enough to give us some notion of the richness and the general character of the faunas of the sub-Antarctic and Antarctic seas. Except a marvellous species of Priapulus, caught in the neighbourhood of La Plata, all the other forms belonging to the groups in question were dredged from the coasts of Patagonia, Tierra del Fuego, the Falklands, South Georgia and the true Antarctic islands.

The animals at my disposal have with a few exceptions been brought up with the dredge from a trifling depth, from the shores and neighbouring waters. Most of the results of the deep-sea explorations was destroyed when the »Antarctic» was lost.

When I decided to undertake an investigation of the Priapulids and Sipunculids, brought home from the southern cold regions, I did so in the expectation of being able to throw some light on the still doubtful phenomenon of bipolarity. It was asserted long ago that the faunas of the two glacial seas in their general feature bear a strong resemblance to each other. This fact may partly be due to similar chemical and physical conditions in the two seas, which are thought to give rise to what is called vicarious or parallel forms, that is to say to a convergence-phenomenon, but the true interpretation is certainly to be sought for much deeper. It must be due to a close relationship.

Considering that several investigators enumerate animals of quite the same species living at the present time in the two polar seas, though they are missing in the enormous oceans separating them from each other, the problem of the bipolarity requires a special and careful inquiry.

Note. As on so many previous occasions, I have to tender my sincere thanks to Mr GEORG LILJEWALL, the skilful Swedish artist, for his assistance in having executed the drawings and undertaken many preparatory researches.

The distinguished investigator of the oceans, Sir JOHN MURRAY,[1] pronounces his opinion with regard to the deep and shallow-water faunas of the Kerguelen region of the great Southern Ocean in the following manner: »In the reports of the specialists who have examined the collections from Kerguelen and other islands of the Southern Ocean, very frequent reference is made to the identical or closely allied species which occur in the cold waters of the Northern and Southern Hemispheres, but have not as yet been recorded from the intervening tropical regions, either in shallow or in deep water. If there be, as indeed seems to be proved by the following investigations, very few widely distributed, or rather universally distributed, species in the deep-sea, and if there be a large number of identical or closely allied species in the colder water of the two hemispheres, wholly separated from each other by the tropics; if in short, the marine faunas towards either pole are genetically more closely related to each other than to any intervening fauna, then we are face to face with one of the most remarkable facts in the distribution of organisms on the surface of the globe. A study and comparison of Arctic and Antarctic marine faunas and floras seem indeed to lead directly to very important suggestions as to the past history of the earth and the gradual evolution of the physical and biological conditions which now prevail over its surface.»

The fauna and flora of the great Southern Ocean evidently exhibit features of the highest interest, widely separated as they are from the arctic seas.

Before proceeding to set forth my own thoughts of the matter in question, I may remind the reader of the fact that there are other distinguished investigators who entertain an opinion differing from that of Sir JOHN MURRAY. Thus, e. g., D'ARCY W. THOMPSON[2] accentuates his doubts in pronouncing the following views: ». . . . It has been maintained by some that this latter is the case; that there is a common bipolar fauna non-existent in the tropics, and even that hundreds of species in the Arctic and Antarctic fauna are identical one with another. This view is contested by others, and I for my part do not share it. But on this question more arguments is much less to be desired than more investigations. For, even supposing the specific identity of so many forms to be disproved, it may be there remains sufficient ground for a similar deduction from the general affinities of the rest: or, on the other hand, if the inference be wholly false, we may find resemblances which are not original, but which throw light on questions of variation and evolution under similar conditions.»

I understand quite well THOMPSON's caution in expressing this views. In conformity with many other investigators he is in doubt whether there really exist similar species in the two polar seas but which are lacking in the intervening regions. I quite agree with him when he says: »But on this question more arguments is much less to be desired than more investigations.» That was just my intention when I began to work out this report. For I thought that every recorded instance of identical bipolar species, non-existent in the tropics and subtropics, would be of value

---

[1] Trans. Roy. Soc. Edinburgh. Vol. 38. Part II. 1896.

[2] The Antarctic Manual for the use of the Expedition of 1901, edited by GEORGE MURRAY. London 1901.

for estimating the nature of the phenomenon of bipolarity. This concerns especially forms which like the species of *Priapulus* have attained such an unusually high degree of speciality, that all convergence-phenomena due to variation and similar physical conditions are excluded. If, in addition, it be proved that the animals in question neither in adult nor in laval stages are capable of moving from polar circle to polar circle and, besides, that they do not exist in intermediate zones, then we are entitled to turn to every scientific man with the question: What is the reason for such a conspicuous resemblance? For science cannot allow that two exactly identical forms have arisen from two sources only by means of variations and similar physical conditions.

Supposing such views were right, then, indeed, the relationship between the organisms would be veiled in a mystery much more chaotic than before Darwin. Therefore it is our duty to try to find a true interpretation of such a very remarkable phenomenon as that of the true bipolarity. Moreover, according to my opinion, the obvious resemblance and the general features of the faunas of the two polar seas must remain mysterious, if we do not admit a closer relationship. It cannot be explained by convergence phenomena alone.

In many instances, it is true, a certain resemblance between the two polar faunas may be explained solely by »variation and evolution under similar conditions», but surely there exist resemblances so intimate, that they are incomprehensible without assumption of a close relationship.

As early as in 1886,[1] *when working with the Challenger Holothurids, I suggested the following views: »It appears scarcely probable that the shore-fauna of two regions so far separated from each other as the arctic and antartic seas, has any direct exchange of forms at the present epoch, so as to allow the same species, in its larval or adult state, to pass from one pole to the opposit without settling at interjacent regions. In brief, I do not believe that at the present epoch the arctic shallow water fauna can directly originate from the antarctic, or vice versa.»... »On the other hand, it is a fact that the two faunas in question resemble each other very closely, and, with regard to the Holothurids, that several forms occur in the arctic sea which are most closely allied to those in the antarctic. I am inclined to suppose that the progenitors of the Holothurids have had a much wider distribution during a past period, that altered physical conditions, a keener struggle for existence etc., under the tropic and the temperate zones have effected their extinction, or their migration towards the polar seas, or even produced changes in their organisation and general appearance so marked, that their descendants which still remain in the tropical zones present themselves as species distinct from the original, and finally that the polar seas with their more uniform physical conditions allowed them and their descendants to live their and to develop slowly but continuously after almost the same plan.»*

Ever since that time I have had no ground for changing my views to any particular extent; for, according to my opinion, it is inconceivable that the shallow-

---

[1] Challenger Report. Zoology. Vol. XIV. Part XXXIX, p. 260; and Ymer, tidskrift utgifven af sällskapet för Antropologi och Geografi. Stockholm 1900. 3.

water faunas of the two polar seas can have any *noticeable* exchange of species either in the adult or in the larval state.

In proceeding to discuss these views I must begin by remarking that I *omit the deep water fauna*, which presents more cosmopolitan features, and that I also prefer to *leave out all the representatives of Holoplankton* which spend their whole life floating on the surface of the sea or in the water layers beneath, because they might happen to be transported far away from the native-place by means of sea-currents.

Though I am conscious of deviating from the actual subject of this paper, I nevertheless avail myself of the opportunity to express in a note below my opinion with regard to the holoplankton animals, because there seem to exist views which do not correspond with my own.

Note. It has been asserted that a permanent exchange of plankton animals is going on between the two polar seas and that the communication takes place in the deeper and colder water-layers under the tropic and subtropic zones. This may be true, but certainly to a very limited extent.

When STEINHAUS states that Sagitta hamata, common in arctic and northern seas, is caught from the cold water in the South under the 40th latitude, and LOHMANN relates that MICHAELSEN has found the northern Fritillaria borealis in abundance off the coasts of Tierra del fuego, then I think it is an open question, whether the animals in question really have been transported by sea-currents from pole to pole, or whether at the present era they have two or, more probably, several birth-places in the oceans. To my conviction, they are capable of producing an offspring in allmost all the places where the adult animals have been met with.

We know several instances of plankton forms with a very wide distribution, und here I will refer to the Copepods, marine animals of the greatest importance for supporting the animal life in the oceans.

In arctic and northern seas we have two forms of rather large Copepods, Calanus firmarchicus (GUNN.) and Calanus hyperboreus KRÖYER, both very representative species and characterising the cold northern water by their appearance in enormous masses. Both of them are very resistant and are evidently capable of living in far different depths. For among their relatives there are several forms which posses the necessary qualities of enduring a life at the surface of the sea as well as at depths of 500, 1,000 or even down to 4,000 m.

According to GIESBRECHT,[1] BRADY[2] and AURIVILLIUS[3] these two species have a quite different extent of their horizontal distribution. In spite of the fact that they pass their life side by side in a sea-area comprising about 16 degrees of latitude or more, the former is distributed in the Atlantic and the Pacific between 85° N. and 52° S., while Calanus hyperboreus is confined to the North Atlantic between 85° N. and 60° N. and is to be looked upon as a genuine arctic form.

The copepods are in possession of a certain motive power of their own, but, considering the immense distances which they are thought to pass over, this must be minimal, their migration and distribution in the oceans being mainly due to the sea-currents. Now, it seems to be indisputable that the two species in question, living side by side in or under an arctic sea-area of about 16 degrees of latitude, must be subjected to the influences of the same currents. Then it remains to explain, why Calanus finmarchicus alone can be disposed by those currents in every direction, in the Atlantic, Baltic, Mediterranean, Pacific etc., while Calanus hyperboreus still dwells in its native arctic water.

---

[1] Das Tierreich. Copepoda. I. Gymnoplea. VI. Berlin 1898.

[2] Challenger Report. Zool. Vol. 8. 1883.

[3] Kungl. Vet. Handl. Vol. 30. 1905.

In my conviction, this fact cannot be explained otherwise than that the latter species is organised exclusively for a life under pure arctic conditions, and that when it is carried away towards the warmer southern zones, it is going to destruction, while Calanus finmarchicus is endowed with a capacity of existing almost as a cosmopolitan, that is to say, it must be provided with such qualities, that it is able to stand very different conditions — and consequently to recruit the pelagic fauna in the oceans far from the *supposed »native place»* in the arctic regions.[1]

For my part, I must confers that I long ago entertained views different from those of other investigators. Thus. e. g., I am convinced that Calanus finmarchicus, supposing it really has this very wide distribution, has its cradle in several or many centres not only in the northern and arctic seas, but probably also in other parts of the oceans. Because, like other animals of the Holoplankton it is born in the open sea and is adapted for a life there, independent of the shores and the sea-bottom. According to the views that I have enunciated here, *all true animals of the Holoplankton with a wide distribution have many cradles in the oceans — never or rarely a single one.* If, for instance, Calanus helgolandicus is met with at Heligoland, in the Mediterranean, in the Black Sea, in several places of the Atlantic and also off New Zealand, is it reasonable to assume off hand that its breeding-place has been the coast of Heligoland alone, and that it should have been drifted by currents from this »centrum» all over the world? At least I myself cannot admit such views. *Therefor I think that those scientists are wrong which have come to the conclusion that they can determine the direction of the sea-currents in the main by the occurrence of holoplankton-animals.*

After this short and superficial introductory discourse of the distribution and life of the holoplankton-animals, I return to the shore and shallow-water fauna, the real subject of my present paper.

The shallow-water fauna comprehends all such animals which inhabit the littoral region down to a depht of about 400 m. In conformity with the German investigator PFEFFER,[2] I consider it to be »the mother of all faunas». For the shallow-water ground offers conditions for existence much more than any other. The sun-beams penetrate the water layers right down to the bottom. The vegetation is luxuriant and abundant in forms of different qualities. The schallow-water is very richly supplied with oxygen, is kept in permanent motion and is, besides, subjected to varying temperature and salinity. Finally, the bottom is highly difform, often rocky and overgrown with forests of algæ. To sum up, all the different conditions have in the course of time raised a fauna of infinite variegation.

---

[1] This account is based on the views of GIESBRECHT, BRADY and AURIVILLIUS. However, SARS (An account of the Crustacea of Norway — Bergen 1903) entertains a different opinion with regard to the distribution of Calanus finmarchicus. He says: »It has, however, been confounded by most authors with the succeeding nearly-allied species [Calanus helgolandicus (CLAUS)]... Of all the marine Calanids of Norway, this form is by far the most common, occurring often in enormous shoals, and thus sometimes giving the sea a conspicuously reddish hue. It is found every where in the open sea, more frequently at the very surface, though at times it may also descend to greater depths... Off the Norwegian coasts I have met with it from Wardö to Jæderen (Tananger), but farther south it seems to be superseded by the succeeding species (Calanus helgolandicus).

[2] Versuch über die erdgeschichtliche Entwicklung der jetzigen Verbreitungsverhältnisse unserer Tierwelt. Hamburg 1891. [THÉEL, Om »bipolaritet» i hafsorganismernas utbredning. Ymer 1900.]

Now, we know that the temperature has a definite influence on the distribution of the animals and on the general features of a fauna. The shallow-water fauna of the warm seas presents itself as quite contrary to that of the polar regions, as it is characterised by a girdle of coral-reefs encircling the tropical and subtropical zones and forming the foundation of an unique fauna and flora, rich in forms and quite different from the faunas of northern and southern seas, this girdle of corals being interrupted only at the west coasts of Africa and America.

The shallow-water faunas, including the littoral ones, of the two polar seas exhibit such a striking resemblance, that the investigator hesitates whether the animals have their cradle in the northern or in the southern cold waters. The literature treating the biology of the polar regions gives sufficient evidence of the truth of this assertion. Every one who has devoted his time to the investigation of the cold faunas, will concur with these views.

In 1896 MURRAY[1] sent forth a survey of the deep and shallow-water fauna of the Kerguelen Region of the great southern ocean, and in this he speaks of »identical or closely-allied species which occur in the colder waters of the Northern and Southern Hemispheres, but have not at yet been recorded from the intervening tropical regions.»

EHLERS,[2] the eminent investigator of the polychœtes, states that no less than five species are bipolar, but have not at yet been recorded from the intervening tropical regions.

Other scientific men who have had the opportunity of examining collections of arctic and antarctic animals, as e. g. LUDWIG[3] and CARLGREN[4] assert with regard to the Holothurioidea, Chrinoidea, Ophiuroidea and Actiniaria, that not a single species is common to the two polar-seas, but both of them admit a great similiarity between the two faunas, due to similar conditions of life. In 1886[5] I pronounced the same views. For I wrote: »*With respect to the arctic and antarctic regions, the observations hitherto made seem to establish that not a single species of the Holothurioidea is common to both seas. Notwithstanding this, the shallow-water fauna of the two regions possesses much the same features.*»

In 1895 the distinguished investigators GEORGE MURRAY and E. S. BARTHOUN[6] write: »These two polar marine floras have been separated as long as there has been climate of any sort on the globe, and out of their poor marine floras there are 54 species that occur north and south of the tropical belt, and, so far as we know, not within it. Whether this needs a new cosmical theory to account for it or not we do not pretend to say, but it appears to support Dr. MURRAY's other statistics, and

---

[1] Trans. Roy. Soc. of Edinburgh. Vol. 38. P. II. 1896.

[2] Polychæten. Hamburger Magalhaenische Sammelreise. Hamburg 1897.

[3] Holothurien, Chrinoideen and Ophiuriden. Hamb. Magalh. Sammelreise. Hamburg 1898 and 1899.

[4] Zoantharien. Hamb. Magalh. Sammelreise. Hamburg 1899.

[5] Report on the Holothurioidea dredged by H. M. S. Challenger 1873—76. P. II. 1886. p. 259.

[6] Phycological Memoirs, being researches made in the botanical department of the British Museum. London 1895.

is more significant in some respects than the agreement of the plankton Algæ, which have a more stable environment than the littoral forms.»

From the above we are entitled to drow the conclusion, that the shallow-water faunas and floras of the two polar seas present very much the same features, that they are more closely related to each other than to any fauna and flora in the intervening tropical and subtropical regions, and that they in many instances present such a great conformity, that several species of the same genus occur in both of them.

If we take for granted that the general feature of the marine faunas of the two cold seas presents a striking resemblance, a fact that cannot be disputed, and, besides, that a limited number of specifically related forms is to be met with in both of them, but absent in the whole intervening tropical and subtropical regions, then we have to seek for the cause of this phenomenon. In order to arrive at an explanation it will be necessary, as I think, to reflect upon and endeavour to throw light on the following particulars:

1. Consequence and extent of convergence with regard to shallow-water animals of cold waters.
2. Faculty of free moving of shallow-water animals in the adult state.
3. Power of larvæ of shallow-water animals to sustain transport by sea-currents, and duration of such a larval period, dependent of currents.
4. Directions and rapidity of sea-currents.
5. Animals devoid of free larvæ.
6. »Relicta»-theory.

With regard to the first particular, every investigator of biology knows that similar physical and chemical conditions call forth an astonishing resemblance between animals and plants of two far separate regions, but up to date nobody has been able to present a single instance which proves that two separate species have become identical only by means of a convergence phenomenon produced solely by the influence of similar physical and chemical conditions. According to our present views, two species never can reunite to one, after they have once separated into two. Supposing these views to be wrong, then the present prevailing conviction of the significance of a true relationship between animals or plants would be a fable and the arranging of a natural system an impossibility.

With regard to the second question, which concerns the possibility of free moving of adult marine invertebrates from polar circle to polar circle, I think it may be possible in some instances, but considering that we are here only considering shallow-water forms and, moreover, that they have to pass over an enormous space, this possibility must be very restricted indeed. Supposing such a migration to be taking place in the present time, then the animals must make their way along the west coasts of Europa and Africa or along the west coast of America, both ways almost devoid of coral-reefs. Their progress is certainly not along the bottom of the deep sea. But who can say for certain that communication-ways exist along the west coasts of the continents?

Moreover, if we take into consideration the immense space of time which must necessarily be required in order to realize such a migration of, e. g., a worm, a crayfish, a sea-urchin etc., then we must draw the conclusion that the animals in question must have been obliged to settle in several intervening places, or in short to have been *cosmopolitans* in the strict sense of the word. Thus, I do not believe that in recent times a direct exchange of adult shallow-water forms can take place between the two polar seas without settling on suitable intervenient places.

The third point concerns the distribution of shallow-water animals in their larval stages when they constitute an integrant part of the »plankton» and consequently drift about on the surface of the sea or in the deeper water layers. Is there any possibility that shallow-water animals in their early stages of development should be able to stand being carried along from polar circle to polar circle? When answering this question, it should be borne in mind that those larvæ are minute and very sensitive organisms, in a high degree dependent on sunlight, abundance of suitable food and almost uniform temperature and salinity. But, above all, we must keep in mind, that their subsistence entirely depends on the depth and the nature of the sea-bottom. For the larva, having reached a more advanced stage of development, must sink to the bottom of the sea in order to settle there and go through their further development. However, the bottom into which they have sunk must be of such a quality as to offer conditions almost identical with those of their native places. — But this is a mere chance. Certainly more than 90 % of the young are doomed to destruction. The mortality during this period of their life must be enormous. It may be gathered from this fact alone that there is very little chance for a shallow-water species of attaining a wider distribution.

During more than twenty years I have had the opportunity of studying these matters at the Swedish marine biological station, Kristineberg, and I have come to the above-mentioned results. The objects of my experiment were shallow-water sea-urchins, especially the common *Parechinus miliaris* (L.) and *Echinocyamus pusillus* O. F. M., the former living on sea-weed, the latter on mud. It must be considered a fact that the greater part of the larvæ of these sea-urchins are doomed to destruction even within the fjord regions. Only thanks to the millions of larvæ which are brought into the world by a single female sea-urchin, can the existence of the species within the native fjord be secured. Owing to insignificant local currents, always varying in the fjords, by far the greater part of the larvæ get drifted to localities with a bottom fatal to them. If they then have attained such a maturity that they must carry on their further life at the bottom, then, according to the natural laws, they must sink and perish. Certainly more than 90 % get destroyed in this way. They have not happened to reach a bottom with favourable conditions. What percentage of the remaining larvæ has been swalloed up by other marine animals or how many of them have been destroyed in other ways, it is of course not possible to state. The gist of all this is that the larvæ have a very hard struggle for existence. A consequence of the above-mentioned facts is, of course, that the native places always shift, and that the local faunas are subjected to great variations. In a previous paper I have treated these questions[1] in a more complete manner.

Moreover, considering that the preceding account concerns the conditions of life of the larvæ within the fjords, how would the conditions be in the open sea? The answer must be: the transport by currents leads to the ruin and destruction of whole generations.

As the object of the present paper is to determine whether it is possible for larvæ of marine shallow-water animals to be transported by currents from polar-circle to polar-circle, or not, I find occasion to quote some accounts of distinguished scientific men, which confirm my views that the struggle for existence in the oceans is very hard, much harder indeed, than can be endured by a larva of a shallow-water animal.

Thus MURRAY[2] relates: »Where cold and warm currents meet at the surface of the oceans, there is a rise of temperature for the animals of the cold currents, and a fall of temperatur for the animals of the warm currents, which results in a plentiful destruction of organisms. The tow-net collections during the Challenger expedition gave frequent illustrations of this fact by the dead animals collected in such positions off the coasts of North America, off the Cape of Good Hope, in the North Pacific and elsewhere.... This destruction of life is not limited to minute pelagic organisms, but occasionally affects animals which live at the bottom of the sea. Some remarkable instances of this kind have been observed between depths of 50 and 100 fathoms of the eastern coast of the United States.»

In 1896 GOODE and BEAN[3] report: »that in 1880 and 1881 the 'Fish Hawk' took tile fish (*Lopholatilus chamæleonticeps*) on several occasions at depths of from 70 to 134 fathoms.... In the months of Mars and April, 1882, vessels arriving at Philadelphia, New-York and Boston reported having passed large numbers of dead or dying fish scattered over an area of many miles, and from descriptions and the occasional specimens brought in, it was evident that the great majority of these were tile fish.... Computations made by Capt. I. W. COLLINS seemed to indicate that an area of from 5,000 to 7,500 square statute miles was so thickly covered with dead or dying fish that their number must have exceeded the enormous number of one billion. Since there were no signs of a disease, and no parasites found in the fish brought in for examination, their death could not have been brought about by either of these causes; and many conjectures were made as to the reason of this wholesale destruction of deep-water fishes, such as would ordinarily be unaffected by conditions prevailing at the surface, submarine volcanoes, heat, cold, and poisonous gases being variously brought forward to account for the loss of life.... The temperature investigations made by Col. MC DONALD have been carefully discussed by him, and he is convinced that the destruction of *Lopholatilus* was due to climatic causes.»

---

[1] Om utvecklingen af Sveriges zool. hafsstation Kristineberg och om djurlifvet i angränsande haf och fjordar. Arkiv för Zoologi. Stockholm 1907.

[2] On the annual range of temperature in the surface water of the ocean and its relation to other oceanographical phenomena. — The Geographical Journal. London 1898.

[3] Oceanic ichthyology. — Mem. Mus. Comp. Anat. Vol. XXII. Cambridge 1896, p. 285—288.

With regard to the above quotation MURRAY says: »It has been estimated that the bottom of the ocean in this region must at the time have been covered to the depth of about six feet with the dead bodies of the tile-fish and other marine organisms, and it seems evident, from the subsequent researches of Prof. LIBBEY, that their destruction was due to the lateral shifting of currents from different sources and of different temperatures, thus producing a wide range of temperature even at depths of 50 and 100 fathoms.» Seeing that the surface and under-currents, when they meet, have the pover to exercise such ruinous influence over such vigorous forms as adult specimens of Cephalopods and fishes, then there is very little chance that the very susceptible larvæ of Evertebrates can sustain the violent struggle for existence in the open sea.

Besides, other facts confirm the accuracy of my views. For, supposing that larvæ of shallow-water animals really could endure the struggle for existence under such perilous and permanent transport by means of unknown and dubious currents from polar-circle to polar-circle, then the consequence must be that a very great number of fully identical species must be met with in the two polar regions. But this is by no means the case. A careful investigation will certainly show that only a very limited number of fully identical species is to be found in the two polar seas.

In this connection, another question of highest importance calls for treatment, and, if possible, solution. How long does a larva of a shallow-water animal live in the open sea without being forced to sink and settle on the bottom? This question is indeed very difficult to answer. According to my practical experience a larva of a sea-urchin goes through its plankton stages during a period of 6 to 8 weeks, varying in accordance to the temperature and the supply of food. In other marine invertebrates the floating stage is gone through more quickly and in many instances this development does not require more than a few days.

The fourth question, concerning the direction and rapidity of the sea-currents seems to be very difficult to answer conclusively. Even a professional hyrographer appears to be in doubt as to the true nature of the deep-water currents. For my part, I admit frankly that my studies have not been such as to warrant me in giving a view of my own on these contested matters. Consequently I must confine myself to giving the opinions of some eminent authorities.

In 1911 KRÜMMEL[1] pronounces his opinion on the deep-water currents in the following manner: »Was die directen Strommessungen betrifft, so ist der Stand unserer Kenntnisse der die tieferen Schichten beherrschenden Strombewegungen zurzeit noch bedauernswert rückständig; . . . Ein wenig günstiger steht es um eine theoretische Beurteilung der Notwendigkeit gewisser stromartiger Wasserversetzungen in den mittleren und unteren Schichten; doch stellt sich auch hier die nicht genau zu beklagende Unzuverlässigkeit der älteren Bestimmungen des Salzgehalts dieser Tiefenschichten hinderlich in den Weg. . . .»

Thus KRÜMMEL states that our present knowledge of the deep-water and under currents in general is unsatisfactory.

---

[1] Handbuch der Oceanographie. Bd. II. Stuttgart 1911, p. 613.

Again, WALTHER,[1] an investigator of unquestionable reputation, says: »Die Geschwindigkeit des Golfstromes . . . beträgt in der Sekunde 1,5—2,5 m., doch wechselt die Geschwindigkeit nach den Jahreszeiten. Mit zunehmender Tiefe nimmt die Geschwindigkeit ab. Am 24 April 1874 fand Challenger in 1,100 m. keine messbare Bewegung mehr. . . . Die Meeresströmungen sind also in erster Linie Oberflächenbewegungen, deren Geschwindigkeit am Boden des tiefen Meeres sehr gering und meist unmessbar klein ist. Ihre mechanische Leistungsfähigkeit ist also mit Rücksicht auf den Meeresgrund und die denselben bewohnenden Organismen überaus geringfügig, obwohl gerade in der geologischen Literatur den Meeresströmungen in dieser Hinsicht irrthümlicher Weise eine ganz hervorragende Rolle zugeschrieben wird.»

Further on, he refers to the well-known fact, that the cold and heavy water of the polar seas, rich in oxygen and food, sinks to the bottom and slides very slowly down to the great oceanic depths in the equatoreal regions, that the descent of the bottom from the polar circle to the equator is only 1: 1,200,000, and that owing to the slightness of the descent and from the resistance offered by the masses of water it encounters, the velocity of the deep currents must be »*eine ganz unmessbar kleine*».

Further, RICHARD[2] agrees with these views when he pronounces as follows: »Supposons qu'il s'agisse de la circulation verticale entre l'équateur et le 30° N: le courant de surface a une vitesse moyenne vers le pôle de 24 milles par jour (ce qui est peu par rapport au Gulf-Stream); admettons une épaisseur de 100 m.; si l'on suppose que 5 % de la masse coule pour être de nouveau aspirée comme courant profond vers l'équateur, on trouve, d'après SCHOTT, que la vitesse de ce courant profond sera de $0^{mm},7$ par seconde, 60^{m} par jour et une même molécule d'eau mettra quelque 150 ans pour revenir du 30° N. à équateur, tandis que le courant superficiel fait le trajet inverse en 80 jours (si l'on suppose qu'il va en line droite, ce qui n'est pas). Le courant profond arrivé sous l'équateur à 3000^{m} de profondeur par exemple mettra 50 jours pour arriver à la surface. Comme on le voit, il s'agit de mouvements extrêmement lents et qui le sont peut-être encore advantage.»

The references quoted evidently prove that our knowledge of the oceanic under and deep-currents is very imperfect, but they nevertheless agree in stating that these currents slide down very slowly, a fact of deepest interest and just in accordance with my own conviction, expressed in 1900.[3]

Taking it for granted that deep and under-water currents move very slowly and, besides, that no currents have been proved to exist which unite the two polar seas in a direct line, I consider it to be almost a proved fact that no exchange of shallow-water animals in their floating larval stages can take place at the present time.

But on deciding this question, other views too ought to be taken into consideration, i. e. all the instances where the larvæ, supposing them to be following the problematical bipolar under-water currents, are exposed to danger of destruction, instances which have been treated above.

---

[1] Einleitung in die Geologie als historische Wissenschaft. Jena 1893—1894, p. 79.

[2] L'Oceanographie. Paris 1908, p. 191.

[3] Om »bipolaritet» i hafsorganismernas utbredning.

As has been mentioned above, a larva of a shallow-water animal keeps in its floating stage for a time ranging from a few days to two months, which certainly in most cases is calculated too high. Supposing, too, that such a larva could sustain a transport from polar-circle to polar-circle, that a direct under-current unites the two circles in a straight line and that that current had a rapidity of the Florida stream at its highest celerity —a thing which in fact is an impossibility — then it may be very instructive to compute the time that would be required for a larva or another object to traverse the space between the two polar-circles.

According to Krümmel, Walther and other distinguished scientific men, the Florida stream runs at a rate of 1,50 to 2,50 m. per second. Presuming that a uniting under-current such as we assume could have a rapidity of 2,50 m. per second — a surface-current of the greatest rapidity in the world, or nearly so — how long would it take for an object to be transported the long distance in question?

The distance in a direct line from polar-circle to polar-circle is about 1,476 miles (a swedish mile = 10 km.). Then the object in question goes 1,500 m. per minute, 90,000 m. per hour and 2,160,000 m. per day, that is to say in round numbers 22 miles per day. In two months the larva has not been transported more than 1,320 miles. Consequently, from these calculations we are entitled to draw the conclusion that the larva is obliged to sink to the deep-bottom and to perish there before having reached the opposite polar-circle. And yet we have calculated with something so absurd as that an under-currents could run in a direct line from polar-circle to polar-circle and with a rapadity of that of the Gulf-stream between Florida and the Bahama Island at a time when it has its greatest velocity.

In view of the above-mentioned reasoning, I may be allowed to put to every scientist the question whether they really believe that a larva of such a limited floating stage can endure the very long transport from polar-circle to polar-circle by means of under-water currents? I think is most unlikely.

Now we may pass over to the fifth point. In appreciating the phenomenon of bipolarity, we have to take into consideration the very important fact, that many marine animals are devoid of floating larval stages and develop in a more direct manner, consequently that their young are totally independent of currents and incapable of removal in any noticeable sense. Such instances are met with especially in the northern and southern regions.

Leaving out the Sipunculids mentioned in this paper, some of them being perhaps cosmopolitans, the *Priapulids* do certainly present a striking example of such an instance. Though nothing is known of their embryology, I think that every naturalist, acquainted with this isolated genus, will agree with me in considering the *Priapulids* to be devoid of the floating larval stages. *Priapulus caudatus* is found in the Baltic sea, off the coasts of Denmark and all along the west coast of Scandinavia, off the coasts of Greenland, Spitzbergen etc. Notwithstanding this, a free floating larva of it has never been observed. The same is the case with its nearest relative, *Halicryptus spinosus*, a relicta-form living only in the arctic and Baltic seas. The latter is common in the archipelago of Stockholm, and for many years and at different seasons I have made repeated attempts to find larvæ — but always without result. On the other hand, I have dredged very small young from a bottom of mud.

Considering that the *Priapulids* in the adult state are incapable of any noticeable removal and that seemingly their young are bound in the same way and, besides, that hitherto not a single specimen of a *Priapulus* has been found under the subequatoreal and equatoreal zones, how then interpret the fact, that representatives of this genus are living in both the cold seas, but entirely absent in the intermediate torrid zones?

In view of the arguments given above, I maintain the following statements with regard to shallow-water animals:

1) *That bipolar animals most closely related to each other exist, though neither in the adult nor in the young stages are they ever capable of any perceptible removal, and are never found living in the intervening regions at the present time.*

2) *That this relation in many or most instances cannot be due to a convergence-phenomenon alone.*

3) *That an exchange of adult animals from polar-circle to polar-circle is quite out of the question.*

4) *That larvæ of shallow-water animals are incapable of sustaining the very long transport from polar-circle to polar-circle.*

5) *That the floating-period of marine larvæ is very limited.*

6) *That under-water currents uniting the two polar seas, even if they run in a straight direction, run so very slowly that they cause the destruction of the larvæ.*

7) *That the phenomenon of a true bipolarity requires a specific interpretation.*

As mentioned above, in working with the Holothurioidea of the Challanger expedition, I had an excellent opportunity of observing the astonishing similarity between northern and southern forms of this group, though I never saw a single species common to both seas.

In view of what was mentioned at the beginning of this paper, the representatives of the genus *Priapulus* or of its progenitors must have had a world-wide distribution during a past period, but for several reasons, e. g. altered physical conditions, they have become extinct under the tropical and temperate zones, but continued to exist in the cold-water regions, where the more uniform physical conditions produced descendants which developed slowly and after almost the same plan. According to this view, the northern *Priapulus caudatus* LAM. and the southern *Priapulus caudatus* forma *tuberculato-spinosus* BAIRD are »*relicta*» of the same progenitors, which at an epoch of the evolution of the globe had a world-wide distribution.

This is the only interprelation which I can give with regard to the bipolarity of the two forms of *Priapulus*, absent in all intermediate zones, devoid of a power of removal of their own in any noticeable sense, and evidently in want of free larval stages.

But, further, I also broached the opinion that the descendants of the progenitors in question, if they were able to sustain the altered physical conditions under the tropic and temperate zones and to adhere there, must get changed in their organisation. — Now we have a new form of a *Priapulus* caught not far from La Plata-river, thus under temperate zones; this *Priapulus* is a genuine one, with all the characteristic peculiarities, which mark this genus, but it differs from the other representatives by its remarkably changed caudal appendage. Further on in my paper, I have named it *Priapulus horridus*, and to my view it may be just such a form which has been capable of sustaining the struggle for existence under subtropical zones. Evidently it has not immigrated from colder zones. In all probability, it ought to be looked on as a *relicta* from that period, when an uniform climate was prewailing all over the world.

Every scientific man who will examine the text and the drawings below must understand, that that strange form of a *Priapulus* is not to be derived from a recent species now living in the polar seas, but that it must be a much altered relict, its closest relatives having had less power of resistance and therefore having got lost.

With regard to the Sipunculides which are mentioned further on in this paper, I cannot state with the same conviction that they are bipolar in the same sense as the Priapulids. To my knowledge, some of them have hitherto not been met with anywhere but under the antarctic and subantarctic zones. But it may be otherwise with regard to the remaining species: *Phascolosoma margaritaceum* (SARS) *Ph. minutum* KEFERSTEIN and *Phascolion strombi* (MONT.). *Ph. margaritaceum* belongs to the cold northern regions and also occurs in the cold southern seas, but is never found under the equatoreal or subequatoreal zones. As to *Ph. minutum* (or *sabellariæ*), for first recorded from the coast of France, Heligoland and Sweden and now, supposing I am right in my identification, also from the subantarctic region, I think it likely that it may be found in the intermediate space, though owing to its diminutiveness and mode of life, it has escaped our attention. It may *possibly* be a cosmopolitan.

The third species, *Phascolion strombi*, has a wide distribution in northern seas, and long ago it is recorded from the coasts of Greenland, Spitzbergen, Sibiria, Scandinavia, England, France, the Mediterranean and North America. If I am right in my supposition that VERRILL's *Ph. tubicola* is identical with it, then it also is found off the coasts of West-India. Now, I have had at my disposal several forms, evidently of this species, caught in the cold southern sea between South Georgia and Falkland Islands. For the present our investigations are too imperfect to allow us to state whether the species in question is a cosmopolitan too. As a matter of fact none of the three species (except *Ph. strombi*) has hitherto been recorded from subtropical seas, either from the west-coast of Africa or of that of America — and in the deep-sea they certainly do not exist.

When I undertook the investigation of the animals in question, I took it for granted that very closely allied forms of a genus which lived in the two polar seas, but not in the intermediate torried zones, must differ in some respects. For they have been separate during an immense space of time and under conditions which cannot have been quite the same. I therefore left no means untried to discover distinguishing marks between them. From the following account of the species, it will be understood that my exertions were crowned with but little success.

How is this fact to be explained, when to our knowledge the species in question are absent in all the intermediate zones? I think only by the assumption that they are »relicta», that their progenitors had a world-wide distribution, and that they are in possession of a remarkable power of resistance.

In 1891 and later on in 1899 PFEFFER[1] entertained the same views, when he wrote: »Sehen wir auf der einen Seite, wie seit dem tertiären Schluss der Landenge von Panama die Tiere auf der Ost- und Westküste der Landende sich in verschiedener Weise weiter umgewandelt haben und auf der anderen Seite, wie die seit viel älteren Zeiten voneinander geschiedene Tiere der hohen Breiten noch zum Teil identisch sind, zum Teil sich ausserordentlich wenig verändert haben, so wird wohl der Gedanke nahe gelegt, dass die allmähliche Abkühlung der polaren Gegenden und eine grössere Einförmigkeit der Lebensbedingungen hemmend auf die Umbildungsfähigkeit der organisierten Substanz gewirkt hat, während das regere Leben und der vielgestaltige Kampf um Dasein in den wärmeren Gegenden die Artenbildung gefördet haben dürfte.»

Furthermore, PFEFFER declares: »Die Vorfahren der heutigen Litoral-Faunen hoher Breiten waren einst über das Litoral der ganzen Erde hin verbreitet. . . . Bis zu alttertiären Zeiten gab es auf Erden keine zonenartigen Faunen, sondern nur eine einzige, über die ganze Erde verbreitete allgemeine Fauna.»

These quotations confirm my own views of the nature of the bipolarity, but PFEFFER has gone further in trying to give an explication of that phenomenon.

Considering that the accuracy of these views are disputed by several scientific men, I think it appropriate to refer also to Sir JOHN MURRAY,[2] who has expressed his opinion in the following manner: »It may therefore be assumed that the identical species now found living towards both poles or their immediate ancestors, had a world-wide distribution, which involves a nearly uniform temperature throughout the whole body of ocean waters. From what has been stated with reference to coral reefs, and from what we see now of the distribution of plants in the coral-period, this appears to have been the actual state of matters during the earlier stages of the earth's history; down to the middle of the Mesozoic time the ocean had, probably, an aproximately uniform temperature of about 70° F. from pole to pole, being probably not much warmer at the equator than elsewhere. The evidence afforded by the distribution of fossils in the geological strata, proceeding backwards in time from the most recent to those of Palæozoic age, indicates that the tropical zones of temperature slowly widens towards the north and south till in the earlier ages it evidently embraced the whole world.»

To my mind the two authors referred to are right, and, for my own part, I must persist in the conviction, that we really have to do with »relicta forms», when

---

[1] Versuch über die erdgeschichtliche Entwickelung der jetzigen Verbreitungsverhältnisse unserer Tierwelt. Hamburg 1891. — Ueber die gegenseitigen Beziehungen der arktischen und antarktischen Fauna (Verh. d. deutschen Zool. Ges. auf d. neunten Jahresversammlung zu Hamburg). Leipzig 1899.

[2] Op. cit.

we in the two polar seas see two identical specimens, absent in the whole intermediate region.

Priapulus caudatus Lam. forma **tuberculato-spinosus** Baird.

Pl. I. figs. 1—12.

1868. *Priapulus tuberculato-spinosus* Baird.[1]
1888. » » » de Guerne.[2]
1889. *Priapulus caudatus* Lam. var. *antarcticus* Michaelsen.[3]
1902. *Priapulus caudatus* Shipley.[4]

Habitat. — Cape Virgin, Patagonia, 37 fathoms, stones, one little specimen (Eugenic Expedition 1851—1853). — Puerto Harberton, Tierra del Fuego, 10—20 fathoms, bottom of dead shells and balanids, two small specimens (Nordenskiöld's Exp. $^{14}/_{2}$ 1896). — Graham region, 64° 3′ s.—56° 37′ w., 360 m., loose clay, a single very minute specimen (Swedish South Polar Exp. $^{11}/_{2}$ 1902). — South Georgia: Kochtopfbucht, 54° 22′ s.—36° 28′ w., 22 m., clay with algæ, a small specimen (Sw. S. P. Exp. $^{30}/_{5}$ 1902. — Falkland Islands: Stanley Harbour, 51° 42′ s.—57° 50′ w., 10 m., mud and shells, a rather large specimen (Sw. S. P. Exp. $^{3}/_{9}$ 1902). — South Georgia; Cumberland Bay in Grytviken, one specimen (E. Sörling 1905).

There cannot be any doubt that all the specimens of Priapulus which have been brought home in the course of time from South Georgia, the Falkland Islands and Tierra del Fuego belong to the same species and, besides, that they are so closely related to the northern *Priapulus caudatus* Lam., that they scarcely can be distinguished. Considering that the Swedish State Museum contains great collections of the northern form I have had excellent opportunities for comparing specimens from the two cold regions. It is true that the specimen from Falkland Islands described by Baird in 1868 obviously presents some differences which, however, may be attributed to individual defects or to a more advanced age. For the specimen examined by Baird was an old one, having attained the considerable length of five inches, while all the antarctic forms at my disposal have been very young or by far not full-grown. Thus, when Baird states that the teeth have only one (the central) spine, and that the lateral small teeth seen in other specimes, appear to be altogether wanting, this evidently is owing to the great age and to these lateral small teeth having been broken or quite worn off.

De Guerne had for investigation four specimens, one from Orange Bay not far from Cape Horn, another from the Strait of Magellan and two from the Falkland

---

[1] Monograph of the species of Worms belonging to the Subclass *Gephyrea*. — Proceed. Zool. Soc. London 1868. p. 106. pl. XI. fig. 3.

[2] Priapulides. — Mission scientifique du Cape Horn. 1882—1883. VI. Zoologie. Paris 1888. p. 9, pl. 1, figs 1, 9; pl. 2, figs 1, 6.

[3] Die Gephyreen von Süd-Georgien nach der Ausbeute der Deutschen Station von 1882—83. — Jahrbuch der Hamburgischen Wissenschaftlichen Anstalt. VI. Hamburg 1889. p. 10. fig. 3.

[4] Gephyrea. — Natural History collections of the »Southern Cross». London. p. 284.

Islands. He also noticed BAIRD's information with regard to the structure of the teeth and added: »A la base de celui-ci se trouvent (contrairement à l'assertion de W. Baird) quatre à six denticulations accessoires.» Nevertheless he did not hesitate to refer his specimens to BAIRD's *Pr. tuberculato-spinosus.*

In 1889 MICHAELSEN published a paper on the Gephyrea of South Georgia, in which he described two specimens of a Priapulus, »der dem arktischen *P. caudatus* LAM. so nahe verwandt ist, dass ich ihn nur als ein Varietät desselben ansehen kann». He named it *Priapulus caudatus* LAM. var. *antarcticus,* and considered it to be identical with DE GUERNE's *P. tuberculato-spinosus,* but seems to entertain some doubts with regard to BAIRD's species of the same name. For he says: »Zu dem Unterschied in der Form der Zähne kommt noch ein anderer. Bei dem Süd-Georgischen Priapulus und bei dem Priapulus DE GUERNE's erleidet der Warzen-Besatz am Hinterende des Stammes eine Unterbrechung in der ventralen Median-Region. Die Bauchstrang-Raphe geht gleichmässig deutlich bis an die Basis des Schwanzanhanges und auch die Ringelung der Haut, die an der mit Warzen besetzten Region nicht erkennbar ist, zeigt sich auf einer schmalen Partie zu Seiten des Hinterendes der Bauchstrang-Raphe. Bei *P. tuberculato-spinosus* BAIRD geht die Bauchstrang-Raphe nicht bis zur Basis des Schwanzanhanges, auch von der Ringelung ist vor dem Hinterende keine Spur zurückgeblieben und der Warzenbesatz tritt bis dicht an die ventrale Medianlinie heran und überdeckt sie sogar an manchen Stellen.»

An inspection, however, of the illustration given by BAIRD evidently reveals that it is a more schematic one, and that the author did not pay any special attention to the posterior end of the body, for I can never believe that e. g. the caudal appendage has had an outer form such as he has drawn it.

The specimens examined by DE GUERNE and myself and brought home from the same locality where the sample of BAIRD has been collected, closely agree with those from South Georgia, Tierra del Fuego, Navarin (FISCHER),[1] Cape Adare (SHIPLEY)[2] and the Graham region (myself). — To my mind, there exists no reason for the supposition that BAIRD's specimen should form an exception.

Therefore I prefer to retain the older name *P. tuberculato-spinosus* of BAIRD.

Now we may return to the main subject of this paper. Most of the authors agree in considering the antarctic Priapulus to be very closely allied to the northern *Priapulus caudatus* LAM., and SHIPLEY seems to look upon them as identical. Neither DE GUERNE nor MICHAELSEN have been able to point out a single distinguishing character.

SKORIKOW[3] alone reports on a certain discrepancy between them, but this is evidently due to a misapprehension. That is at least my idea of the matter. For he says: »Die Varietät [*P. caudatus* var. *antarcticus* MICH.] unterscheidet sich von der typischen Art [*P. caudatus* LAM.] dadurch, dass sie am hinteren Körperende un-

---

[1] Gephyreen. Hamburger Magalhaensische Sammelreise. I. Hamburg 1896.

[2] Gephyrea. Report on the Collections of Nat. History made in the Antarctic regions during the voyage of the »Southern Cross». London 1902. p. 284.

[3] Über die geographische Verbreitung einer Priapuliden (Gephyrea). — Zool. Anzeiger. XXV. 1902. p. 155.

mittelbar über dem Schwanzanhang, einen Gürtel dicht neben einander stehender Warzen hat, die, hell gefärbt, bei grösseren Exemplaren mit unbewaffnetem Auge gut zu sehen sind. Dieser Gürtel wird auf eine grössere oder kleinere Strecke nur da unterbrochen, wo längs der Bauchseite ein hervorstehender Wulst, nämlich die Bauchnacht durchzieht. In allem Übrigen unterscheidet sich die antarktische Varietät von *P. caudatus* nicht mehr, als die einzelnen Exemplare des letzteren sich unter einander unterscheiden; . . . .»

But now it is a fact, that all the specimens from Greenland, Spitzbergen, the west coast of Sweden, the Baltic etc., which have been examined by myself, are provided with such a girdle of warts round the extremity of the body in front of the caudal appendage. And this girdle, too, is always broken on the ventral surface, just as is seen on pl. I. figs. 9—11 and in the figures 4—6 in the text, giving rise to a wider or narrower space in the median line, where the annulation of the body-wall itself is more or less conspicuous. The figures referred to show that there is a great variation with regard to the size and extent of the warts and to the wideness of the ventral median space devoid of them. This variation is independent of the different localities where the worms have been caught, as it is quite as apparent in animals living in one and the same place.

Figure 5 on pl. I represents a ventral view of the posterior portion of a small specimen from the Falkland Islands showing the »ventral empty space» with distinct traces of an annulation. It should be borne in mind that this annulation is very variable even in northern forms of Priapulus, and that it in some cases is almost inconspicuous.

In view of the above-mentioned facts, it lies very near to draw the conclusion that the arctic and antarctic forms of Priapulus resemble each other in all respects This, however, is by no means the case. For a closer investigation reveals that there really exists a constant distinction between them, which has escaped the attention of previous authors. Though this distinction seems to be constant and invariable and consequently not unimportant, I am nevertheless in doubt whether it is of such nature as to be of specific value. The dissimilarity is to be found in the structure of the teeth.

Seeing that no true distinctions have been indicated by previous authors, I decided to undertake a detailed investigation of their teeth, and at my request the skilful artist Mr GEORG LILJEVALL began the arduous task of drawing them on an enlarged scale. The results are shown on plate I, where the three great figures represent views of the dentary apparatus of an arctic and antarctic *Priapulus caudatus* LAM. and, besides, of an arctic *Priapulus bicaudatus* DAN.

An inspection of the figures in question proves that the teeth of the three specimens differ in some, more or less obvious, manner, though they are, of course, constructed after the same plan. In order to illustrate their arrangement more plainly, I have annexed to the text three diagrams. From these as well as from the plate I, it becomes evident that the anterior sets of teeth are disposed in alternating regular pentagons, situated the one inside the other, and that they are provided with one large central spine bearing one, two or several smaller secondary ones on each side. The order of the respective pentagons is counted from without towards the interior. In the three or four first orders of pentagons the teeth gradually increase, the first having the smallest ones. In the following they decrease in size and pass imperceptibly over into the seemingly more disordered armature of the oesophagus. The innermost teeth are reprented by minute pointed warts (figs. 1 a, 6 a and 12 a).

In *Priapulus caudatus* Lam., from northern and arctic regions, seven pentagons are distinguishable (fig. 6 and fig. 1 in the text). The teeth of each pentagon are of equal size. The teeth of the first pentagon are rather large, though of course smaller than those of the three succeeding pentagons, and disposed in such a manner that one of them has its place in the ventral median line. On each side of the powerful central spine, the teeth bear one or two, seldom more, lateral rather strong spines, often of a somewhat irregular shape and position.[1] The small teeth of the gullet are more irregular in shape and provided with two lateral spines on each side.

In *Priapulus caudatus* forma *tuberculato-spinosus* Baird, from the antarctic sea, six pentagons are distinguishable (fig. 1 and fig. 2 in the text). The teeth of each pentagon are equal in size, except the two opposite dorsal ones of the fourth pentagon, these being considerably greater than the remaining ones. The teeth of the first pentagon are minute in size and disposed like those in *Priapulus caudatus* Lam., but their central and three or four lateral spines are diminutive and obtuse. On each side of the powerful central spine, the teeth bear three or four lateral spines, regular in shape an position. In the smaller irregularly arranged teeth, inside the pentagons, the number of lateral spines increases up to seven or eight, but decreases again towards the interior of the gullet.

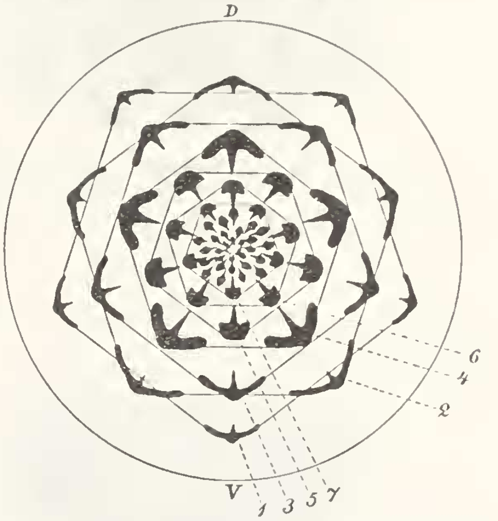

Fig. 1. *Priapulus caudatus* Lam. Diagram of the dentary apparatus. D, dorsal side; V, ventral side; 1—7, the seven pentagons of teeth.

In *Priapulus bicaudatus* Dan., from the arctic sea, five pentagons are distinguishable (fig. 12 and textfig. 3). The teeth of each pentagon are of equal size. The teeth of the first pentagon are minute in size and divided in two, which do not form the angles of the pentagon but are situated on each side of them; consequently the first pentagon has ten teeth,[2] disposed in five pairs. Each of those teeth which constitute a pair has a somewhat triangular shape and is provided with small obtuse protrusions, corresponding to the spines in other teeth. On each side of the forcible central spine, the teeth bear three to five lateral spines. In the smaller irregular teeth, inside the

---

[1] In a little specimen from Spitzbergen (Whales Point) the lateral spines on each side of the central one varied from one to five. In full-grown specimens, the lateral spines of the teeth of the seven pentagons are strong and range from one to two, seldom three.

[2] Koren and Danielssen have overlooked the teeth of the first pentagon. Fauna littoralis Norvegiæ. III. Bergen 1877. p. 148.

pentagons, the number of lateral spines increases up to ten, but decreases again towards the interior of the gullet.

From the above-given account of the dentary systems of the three forms of Priapulus, it becomes evident that they are built after the same plan and present the greatest resemblances, but that they, nevertheless, exhibit some constant differences.

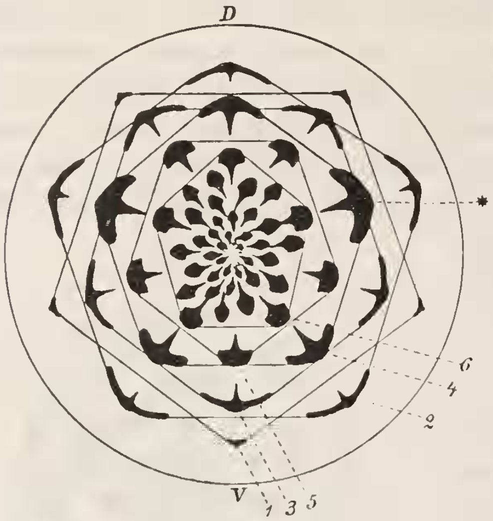

Fig. 2.

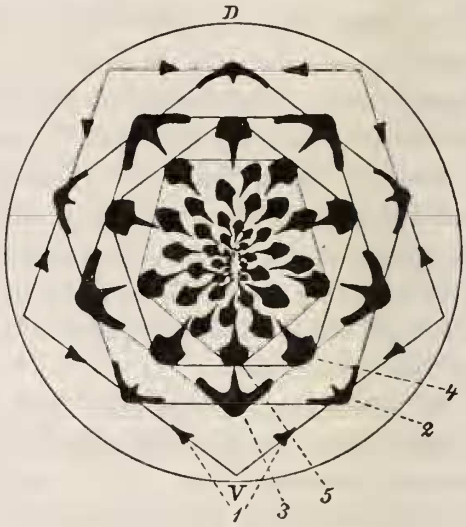

Fig 3.

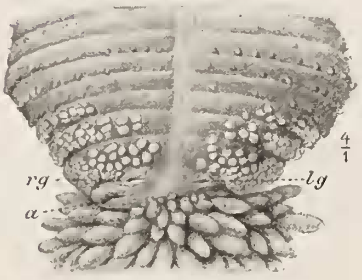

Fig. 4.

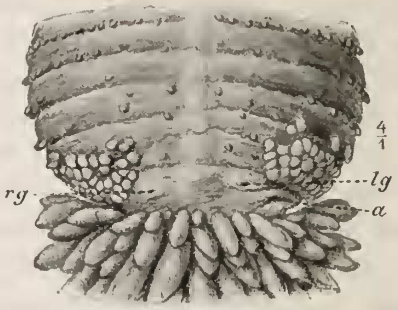

Fig. 5.

Fig. 2. *Priapulus caudatus* Lam. forma *tuberculato-spinosus* Baird. Diagram of the dentary apparatus. D, dorsal side; V, ventral side; 1—6, the six pentagons of teeth; *, the pair of large teeth.

Fig. 3. *Priapulus bicaudatus* Dan. Diagram of the dentary apparatus. D, dorsal side; V, ventral side; 1—5, the five pentagons of teeth.

Fig. 4. Ventral view of the posterior part of a male specimen of *Priapulus caudatus* Lam, from the West-coast of Sweden: Gullmar fjord. a, anal aperture; rg, right genital pore; lg, left genital pore. The median space devoid of warts should be noticed.

Fig. 5. Ventral view of the posterior part of a female specimen of *Priapulus caudatus* Lam. from Spitzbergen: Ice fjord. a, anal aperture; rg, right genital pore; lg, left genital pore. The median space devoid of warts should be noticed.

When I was studying the arctic specimens of *Priapulus caudatus* in order to compare them with those from the antarctic region, my attention was attracted to some remarkable arrangements in the organisation which are worthy of being mentioned. The annexed figures in the text explain satisfactorily the nature of these arrangements, which have hitherto, as faras I know, been almost entirely ignored.

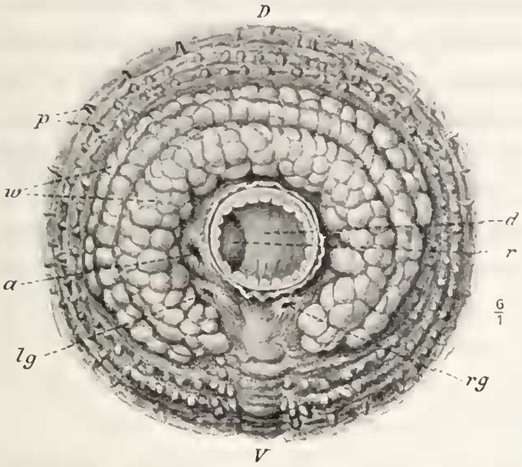

Fig. 6.

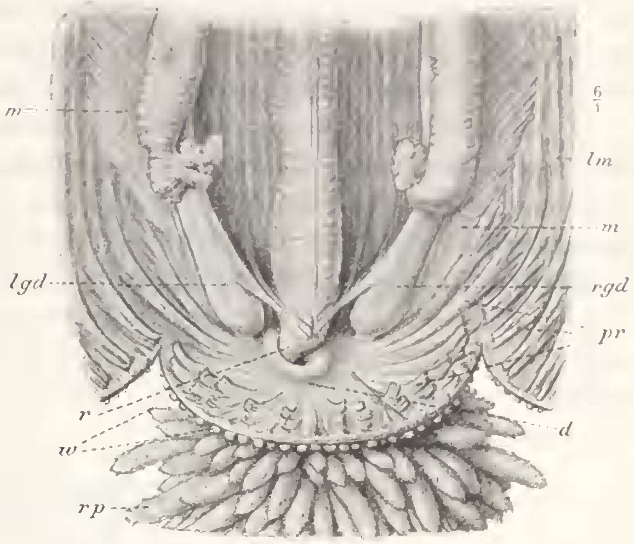

Fig. 7.

Fig. 6. View of the posterior extremity of a female specimen of *Priapulus caudatus* Lam. from Spitzbergen: Treurenburg bay; the caudal appendage having been cut away. D, dorsal surface; V, ventral surface with the space in want of warts; a, anal aperture; d, diaphragmatic muscular membrane separating the cavity of the trunk from that of the caudal appendage and provided with an opening for the rectum; p, papillæ; r, rectum; w, girdle of warts; lg, left genital pore; rg, right genital pore.

Fig. 7. View of the interior of the posterior portion of the trunk of a female *Priapulus caudatus* Lam. from Gullmar fjord. d, diaphragmatic muscular membrane with an opening for the rectum: lm, longitudinal muscular bands of the body-wall; m, mesenteric membrane of the genital glands; lgd, left genital duct; rgd, right genital duct; pr, posterior retractive muscular bands; r, rectum; rp, respiratory lobes of the caudal appendage; w, warts.

Fig. 8. View of the interior of the posterior part of the trunk of a male *Priapulus caudatus* Lam. from the Gullmar fjord; the left portion of the body-wall with the left genital gland having been cut away. d, diaphragmatic muscular membrane, separating the two cavities and provided with an opening for the rectum; m, mesentery of the right genital gland; pr, posterior retractive muscular bands; rm, rectal muscles; rgd, right genital duct; r, rectum; rp, respiratory lobes of the caudal appendage; p, papillæ; t, chitinoid cuticle; n, nerve-cord; tm, transversal muscular layer; lm, longitudinal muscular bands; w, warts; rp, respiratory lobes.

It is asserted that the anal aperture has a dorsal position. In all the specimens which I have examined, from the arctic sea or from the coasts of Sweden, I can state that it is ventral and lies slightly laterally to either of the genital pores, which are invariably situated posteriorly on each side of the posterior prolongation of the nerve-cord (figs. 4, 5 an 6 in the text). More than 16 individuals have been subjected to a careful investigation, 6 brought home from Treurenburg Bay, 2 from Icefjord (Spitzbergen) and 8 from Gullmarn off the west coast of Sweden.

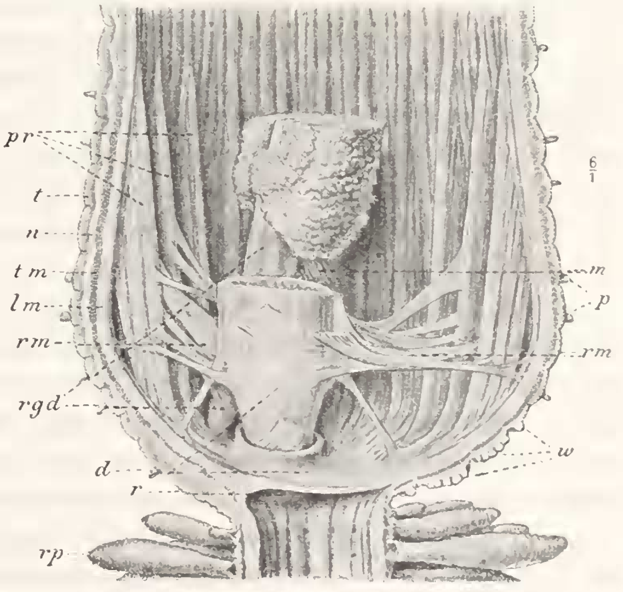

Fig. 8.

Now, it is remarkable that the position of the anal aperture should not be confined to a fixed place; for in 6 specimens examined it had its place on the right side of the genital pores, and in 10 specimens it was situated on the left side of them.

Considering that all the sex specimes first examined, had the anus on the right side and were males, and that seven of the remaining ones had the anus on the left side and were females, I thought at first that I had come a cross a case of sexual dimorphism. But this supposition did not hold good, since I found that three specimens were males, though they had the anus on the left side.

With regard to other conditions in the organisation of *Priapulus caudatus* which, to my mind, have been almost ignored, I refer the reader to the figures 6—8 in text and to the explanations of them.

Priapulus horridus n.

Pl. II. figs. 13—19.

Introvert about a fourth of the total body-length, provided with small sparse conical papillæ arranged in 25 longitudinal rows. Trunk glassy, transparent, annulated, with about 29 or 30 distinctly marked rings. Caudal appendage, slightly longer than a fourth of the total animal, divided by circular incisions into four segments, the terminal one being most voluminous, covered with powerful spines and carrying anteriorly remains of small respiratory bladders. Mouth with chitinous teeth.

Total length of the animal about 6 mm.; introvert = 1,3 mm.; trunk = 2,6 mm.; caudal appendage = 1,9 mm.

Habitat. — Coast of Uruguay, 33° 0′ s.—51° 10′ w., 80 m., blackish grey clay. Swedish South-Polar Expedition, $^{12}/_{12}$ 1901. — A single specimen.

Considering that only a single specimen of minute dimensions has been at my disposal for examination, the diagnosis and the description must needs be very deficient.

The introvert deviates conspicuously from that of other Priapulids. Its papillæ are diminutive and sparse, which results in the disposition of them in 25 longitudinal rows being somewhat obscure, this being the case especially in the posterior half of the introvert, where it is almost devoid of papillæ. Owing to this property the species assumes a somewhat strange appearance. For, in the other known species the papillæ are rather large and lie close together, forming 25 very distinct longitudinal rows all along the introvert (figs. 13 and 14).

The skin of the tkunk is glassy and transparent, the alimentary canal, the retractor muscles and the reproductive organs being discernible through it. It presents 29 or 30 rings, which are sharply marked by rather deep incisions between them. Posteriorly, the trunk is characterized by a circular ridge and by its body-wall being bent inwards towards that place where the caudal-appendage takes its origin, thus presenting an almust truncate aspect.

The girdle of warts round the posterior extremity of the trunk — so characteristic of the forms of *Priapulus caudatus* — seems to be absent, or possibly they are replaced by the minute elevations on the truncated end of the body, which are distinguishable only under a higher magnifying power.

The nerve-cord is discernible as a light line along the ventral surface of the trunk (fig. 13).

The caudal appendage, representing a direct prolongation of the body and its cavity, has a club-shaped appearance, narrowest at the base and widest at the free end (figs. 13, 18 and 19). It is divided by three constrictions into four segments, which gradually decrease in length, the foremost one being the longest. Besides, the second one presents traces of a division into two. The whole surface of that curious organ is covered with slightly curved spines or hooks, which are smaller and more crowded on the first segment; hence they gradually decrease in number but increase in size, those on the terminal segment being rather powerful. The arrangement of the spines seems to be somewhat irregular.

Moreover, the caudal appendage is remarkable for another singularity, its first segment being furnished with a number of hollow bladders or sacks, which evidently correspond to the cylindrical or fusiform tubes which cover the whole surface of the caudal portion of other Priapulids, giving it a shrub-like appearance. In the only specimen at my disposal the second segment also was furnished with such a bladder (fig. 18).

I think there can be no doubt that the bladders in question are remains from a past epoch, when *Priapulus horridus*, devoid of spines or hooks, was provided with a shrub-like caudal appendage, like other Priapulids.

According to my views the caudal appendage armed with spines or hooks in specimens of Priapulids ought to be looked on as a secondary acquisition not as an original one.

The oral aperture has its position as usual in the centre of the free end of the introvert and is armed with teeth. By an accident the very small preparation representing the armed parts of the mouth and oesophagus was lost, a few broken teeth alone being left (figs. 15 and 16). On account of this accident I am unable to state the true construction of the dentary apparatus. However, to judge from the fragmentary remains, the shape of the teeth must have had a structure similar to that of other Priapulids, or nearly so. Each tooth seems to have been provided with a central larger spine and several small lateral ones. The fig. 15 with five lateral spines on each side evidently represents a tooth from the oesophagus.

The intestine descends from the oesophagus in an almost straight direction to the rectum, which passes through the excentric opening of the muscular diaphragmatic membrane which separates the body-cavity from that of the caudal appendage, and terminates in the anal aperture. With regard to this aperture, I have not been able to state its true position, but very likely it should be situated on either side on the genital pores and behind them, as is the case in *Priapulus caudatus* (fig. 17).

The reproductive organs are two in number, large and filled up with well-developed eggs (fig. 17). They are connected with the wall of the body by mesenteries, and their efferent ducts open posteriorly on each side of the nerve-cord.

The thin body-wall is strengthened by circular and longitudinal muscles. The former constitute a continuous layer all over the body on the outside of the latter, which present a somewhat different disposition (fig. 17). In the trunk they form a continuous layer, except posteriorly, where the longitudinal fibres are separated into bands which converge and terminate round the margin of the muscular diaphragmatic membrane. They probably function as a kind of retractors. In the introvert, on the other hand, all the longitudinal muscular fibres are separated into distinct bands.

With regard to the true retractors, I counted eight long ones, two of which run out from the body-wall in front of the remaining ones, which originate from the middle of the trunk. Concerning the short retractors of the introvert, they exist, though I have not been able to state their number.

Phascolosoma margaritaceum (Sars) (?).

Pl. II, fig. 20 and Pl. V, figs. 67 and 68.

1851. *Sipunculus margaritaceus* Sars.[1]
1868. *Phascolosoma capsiforme* Baird.[2]
1889. » *antarcticum* Michaelsen.[3]
1889. » *fuscum* Michaelsen.[3]
1889. » *georgianum* Michaelsen.[3]
1896. » *margaritaceum* (Sars) var. *capsiforme* Baird. Fischer.[4]

Habitat. — Falkland Islands: Port Louis, Mouth of Carenage Creek, 3—4 m., shells and stones, $^{9}/_{8}$ 1902. Three large specimens of a dirty brown colour. — Port Louis, the shore, $^{30}/_{7}$ 1902. Four whitish specimens of ordinary size. — Port Louis, Greenpatch, 7 m., mud and gravel, $^{28}/_{7}$ 1902. One ordinary specimen. — Port Albemarle, 15 m., sand and algæ. $^{8}/_{9}$ 1902. One specimen. — Port Albemarle, 18—30 m., sand, $^{11}/_{9}$ 1902. Three small specimens. — West Point Island (Sw. Mag. Exp. $^{5}/_{12}$ 1907). — Port William, 17 m., sand, $^{3}/_{9}$ 1902. Two brown specimens. — Stanley Harbour, 10 m., mud and shells, $^{3}/_{9}$ 1902. Sixteen small specimens. — South Georgia: Cumberland Bay: »Grytviken», 22 m., clay and algæ, $^{30}/_{5}$ 1902. Several small specimens. — »Majviken», 75 m., clay and algæ, $^{14}/_{5}$ 1902. Many small specimens. — »Sydfjord», 195 m., clay and stones, $^{29}/_{5}$ 1902. Many small specimens. — Tierra del Fuego: Punta Arenas, Tribune Bank, Puerto Eugenia, Gente Grande, Puerto Harris. From all these localities a number of specimens have been brought home by the Swedish Expedition 1895—96. — Graham Region: 64° 20′ S.—56° 38′ W., 150 m., sand and gravel; $^{16}/_{4}$ 1902. Six specimens. — 65° 56′ S.—54° 35′ W., 920 m., mud and stones; $^{22}/_{1}$ 1902. One very minute specimen. — SW of Snow Hill Island, 125 m., clay and stones, $^{21}/_{1}$ 1902. One specimen.

---

[1] Beretning om en i Sommeren 1849 foretagen zoologisk Reise i Lofoten og Finmarken. — Nyt Mag. f. Naturvidenskaberne. VI. Christiania 1851, p. 196.

[2] Proceed. Zool. Soc. London 1868, p. 83, pl. IX, fig. 3.

[3] Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten. VI. Hamburg 1889, p. 3, figs. 4 a—c.

[4] Gephyreen. Hamburger Magalhaensische Sammelreise. I. Hamburg 1896, p. 3.

The collections of *Phascolosoma margaritaceum* are comprehensive enough and contain forms of all dimensions, ranging from samples of a few millimeters to giant specimens measuring 125 mm. or more in length. The largest specimens have been brought home from Port Louise in the Falkland Islands, and among them some individuals have a whitish-gray colour, while other specimens are dirty brown with the posterior pointed end slightly darker. Two forms from Port William in the Falkland Islands are dark brown. These differences in colouring are not of any consequence for the relationship of the forms in question.

Some years ago I had the opportunity of examining the very rich collections of arctic *Phascolosoma*-specimens which are kept in the Swedish State Museum,[1] and which also contain samples of all dimensions. Consequently I have had an excellent opportunity for drawing comparisons between the specimens of the two cold seas. Nevertheless, all my endeavours to exhibit true differences between them were fruitless.

Even the young specimens of the two cold seas resemble one another very closely. In both of them the number of the tentacles is much diminished, and the papillæ of the body-wall are comparatively more prominent than in older specimens. In the antarctic small forms those papillæ seem often to have a darker colour.

The sample which is rendered on plate II has a length of about 69 mm., is provided with 60 tentacles (fig. 67) and is in possession of ciliated sense-pads common to most of the Sipunculids. The inner organisation of the two antipods is quite the same (fig. 68).

In 1889 MICHAELSEN[2] examined samples of this species from South Georgia and described them under the name of *Phascolosoma antarcticum* n. sp. But, to judge from the following quotations, he was in doubt whether he was right in refering them to a new species. For he says: »*Ph. antarcticum* steht dem *Ph. margaritaceum* SARS auffallend nahe; es war ursprünglich sogar meine Absicht, diese Tiere unter dem Namen *Ph. margaritaceum* SARS var. *antarcticum* zu beschreiben. Die Untersuchung der übrigen Phascolosomen von Süd-Georgien liess mich meine Ansicht ändern.» Further on he continues: »Ich beschreibe deshalb sowohl *Ph. fuscum* wie auch *Ph. antarcticum* als gesonderte Arten, mit dem Hinweis, dass sie wahrscheinlich als Unterarten des *Ph. margaritaceum* auzusehen sind, ebenso wie *Ph. capsiforme* BAIRD und *Ph. papillosum* THOMPS.»

Later on in 1896 FISCHER[3] submitted the matter to a renewed discussion and sets forth his view as follows: »Ich vereine desshalb dieser Form [*Ph. capsiforme*] nebst den südgeorgischen Phascolosomen (*Ph. antarcticum* MICH., *Ph. fuscum* MICH. und *Ph. georgianum* MICH.) mit den nordischen *Ph. margaritaceum* SARS zu einer Art.»

Considering that I have in vain sought for differences of such significance as to admit the maintenance of the above-mentioned species, I quite agree with FISCHER in regarding them as representatives of our northern *Ph. margaritaceum*. Moreover, I think it appropriate to reject the varieties too.

---

[1] Kungl. Svenska Vetenskapsakademiens Handlingar. Bd. 39. 1905.

[2] Op. cit.

[3] Op. cit.

Phascolosoma anderssoni n. sp.

Pl. III, figs. 28—34 and Pl. V, figs. 71—74.

Habitat. — South Georgia: »Sydfjord», Nordenskiöld glacier, 195 m., clay with stones, $^{29}/_{5}$ 1902. One specimen. »Majviken», 75 m., clay with algæ, $^{14}/_{5}$ 1902. Three small specimens. — Mouth of Cumberland Bay, 252—310 m., grayish clay with stones. One small specimen. — Graham Region, 64° 3′ S.—56° 37′ W., 360 m.(?). Four large specimens.

Total length of the largest specimen more than 100 mm. Body slender, elongate, tapering towards the posterior extremity. Proboscis, when fully extended, nearly as long as the trunk itself. Tentacles short, obtuse, 21 in number. Skin thin, shining, semi-transparent, covered with small cylindrical papillæ and provided posteriorly in front of the extremity with a broad girdle of rather large, conical bladders with their tops directed forward. Hooks absent. Ciliated sense-pads present. Two free segmental organs. Muscular layers of the body-wall continuous and not separated into bands, Two ventral and two dorsal retractors. Intestinal spiral composed of about 24 double turns and not attached posteriorly. Diverticle present.

The girdle of bladders slightly in front of the posterior extremity of the body gives to the animal a striking appearance. Moreover, in some specimens, that portion of the body where the girdle is situated presents itself as somewhat swelled. The bladders are visible to the naked eye, and are closely crowded, thus forming a girdle about 10 mm. broad (figs. 28 and 29). Each bladder is sacciform and more or less distinctly conical with the top directed forward; it bears one or several papillæ like those of the remaining parts of the body-wall (fig. 33). The slender tail-like portion of the trunk behind that girdle is covered with small cylindrical papillæ which lie more closely together at the end itself (fig. 32). In the transition from the girdle to the tail those papillæ rest on broad sack-like bases (fig. 34). The whole surface of the skin carries small cylindrical papillæ which are more or less crowded, so that it gets the aspect of being hairy; at the middle of the body they are more scattered (figs. 30 and 31).

From the diagnosis it will be seen that the species is devoid of hooks. I counted 21 tentacles (figs. 72—74), 11 on the right and 10 on the left side of the median line. Immediately behind the median dorsal tentacles there are two ciliated sense-pads, each of a rounded triangular shape; they are separated by a median furrow (fig. 73).

Considering that the Sipunculids in general are in possession of a violent power of contraction, either total or partial, it is almost impossible to state the true length of their bodies or the proportions of their different parts. When fully extended, the species ought to be longer than stated above. The anus opens, most probably, near the middle of the body, and the pores of the two segmental organs seem to have their places immediately in front of that aperture. The dorsal retractors are attached slightly behind the middle of the body and the ventral ones further back (fig. 71).

The intestinal spiral is composed of about 24 double turns, and is free posteriorly but in possession of a spindle-shaped muscle (fig. 71). In front attached to the posterior part of the oesophagus, there is to be observed a fixing muscle. The insertion of the rectum is strenghthened by strong muscles. A small diverticle is present. Though I have been unsuccesful in searching for a contractile vessel along the oesophagus, it cannot be doubted that such a tube really exists.

As to the external appearance the species in question seems to present a certain resemblace to *Phascolosoma flagiferum* of SELENKA,[1] but on account of several important distinguishing characters they are to be kept apart.

Phascolosoma ohlini n. sp.

Pl, II, figs. 21—23. Pl. III, figs. 24—27 and Pl. V, figs. 69 and 70.

Habitat. — South Georgia: »Majviken», 75 m., clay with algæ, $^{14}/_{5}$ 1902. Two specimen. — »Grytviken», 24—52 m., clay with algæ, $^{21}/_{5}$ 1902. Two specimens. — North of Astrolabe Island: 63° 9′ S.—58° 17′ W., 95 m., clay mixted with sand, stones and algæ, $^{28}/_{12}$ 1902. One minute specimen.

Total length of the body 16 or 17 mm. Body elongate, subcylindrical, with the posterior extremity pointed. Tentacles slender, 16 in number, arranged in groups on each side of the median line. Distinct ciliated sense-pads present, separating the dorsal tentacles. Skin whitish, shining with small cylindrical papillæ, crowded at the posterior extremity of the body and scarce at its middle. Behind the tentacles mammillary wart-like papillæ and scattered hooks, both directed backwardly. Two free segmental organs. Muscular layers of the body-wall continuous, not separated into bands. Two ventral and two dorsal retractors. Intestinal spiral composed of about 14 double turns and not attached posteriorly.

The papillæ of the body-wall have in general a cylindrical form and are crowded at the posterior extremity (figs. 25—27), while they are much scattered at the middle of the body (fig. 24). Towards the proboscis they increase again in number as well as in size. Behind the tentacles they have become changed in form, presenting themselves as rather prominent rounded mammillary warts, having their tops directed backwardly (figs. 22 and 23). The hooks scattered among them are strongly curved and have the same direction.

As to the arrangement of the tentacles, it deviates considerably from that of the preceding species. Their number is 16 and they form two groups, one on each side of the median line. In the small specimen from Astrolabe Island, 6 mm. long, there are only 9 or 10 tentacles. On the dorsal side the two groups are widely separated, the ciliated sense-pads having occupied the space between them. Those pads are separated by a deeper furrow, and each of them is divided in two by a shallow groove (fig. 69).

---

[1] Report on the Gephyrea. Challenger Report. Zoology. Vol. XIII, 1885.

The total length of the specimens from »Majviken» in Cumberland Bay was stated to be 16 or 17 mm. Later on I have met with two other specimens from »Grytviken» in the same fjord which are about twice as long and have the body-cavity filled with eggs.

The anal aperture is situated at the middle of the body, and the pores of the segmental organs have their places on a level with that opening. The dorsal retractors are attached slightly behind the middle of the body and the ventral ones further backwards (fig. 70).

The intestinal tube with its 14 double turns is free posteriorly and is furnished with a spindle-shaped muscle. A fixing muscle is attached to the posterior part of the oesophagus.

I have not been able to discover any contractile vessel along the oesophagus, though such a tube may very likely exist. The reproductive organs are well developed.

This species must be related to *Phascolosoma cylindratum* of KEFERSTEIN, but differs from it by the form and arrangement of the hook, by the presence of papillæ etc.

Phascolosoma nordenskjöldi n.

Pl. III, figs. 35—41.

Habitat. — Falkland Islands: Port William, 12 m., sand and gravel, $^{3}/_{9}$ 1902. Three small specimens. — South Georgia: »Sydfjorden», 195 m., clay with stones, $^{29}/_{5}$ 1902. Several small specimens, the largest measuring about 9 mm. in lenght. — »Moränfjorden», 64—74 m., grayish clay with stones, $^{16}/_{5}$ 1902. Some minute specimens.

Total length of the largest specimen about 9 mm. Body elongate, subcylindrical, having the posterior extremity more or less rounded. Two small tentacle-lobes. Skin annulate, shining, with small papillæ scattered over the body, but slightly more crowded posteriorly. Behind the tentacles a girdle of hooks and papillæ. Two free segmental organs. Muscular layers of the body-wall continuous, not separated into bands. Two ventral and two dorsal retractors. Intestinal spiral composed of about 14 turns and not attached posteriorly.

The most characteristic feature of this species is the presence of only two tentacle-lobes (fig. 37) of quite the same shape as those in *Phascolosoma* (*Petalostoma*) *minutum* KEFERSTEIN. Also in other respects there exists a certain resemblance. Supposing that the descriptions of KEFERSTEIN and SELENKA had been correct, then I should not have hesitated to refer this form to *Ph. minutum*, but since PAUL[1] has shown that the species of KEFERSTEIN is provided with only two retractors, the antarctic samples may represent a new species.

The body-wall is folded in a series of rings by means of numerous close-lying transverse ridges, which at the posterior extremity of the body are broken up and wrinkled, thus giving rise to an irregular net-work (figs. 40 and 41). The small

---

[1] Über Petalostoma minutum. Zool. Jahrbücher. Bd. 29. Jena 1909.

papillæ are scattered all over the body, except posteriorly, where they are more crowded. The hooks behind the tentacles are more or less sparse and intermingled with papillæ. They have a crooked appearance (figs. 37—39).

The anus and the pores of the two segmental organs open at about the middle of the body, almost on a level with each other. The dorsal retractors are attached slightly behind those openings, and the ventral ones further backwards (figs. 35 and 36). I have not been able to make out whether the animal is in possession of a contractile vessel or not.

Phascolosoma minutum KEFERSTEIN (?).

Pl. III, figs. 42—45 and Pl. IV, figs. 46—49.

Habitat. — Falkland islands: Port William, 12 m., sand and stones, $^3/_9$ 1902. 6 minute specimens.

Total length of the largest specimen 5 mm. Trunk cylindrical, slightly tapering behind (fig. 42—43). True tentacles absent and replaced by some irregular, rounded prominences of the oral disk (figs. 44—45). Skin shining, of a brownish colour, provided with minute papillæ (figs. 46—49). Hooks absent. Two ventral retractors attached slightly in front of the posterior extremity of the body. Two free segmental organs. Intestinal spiral composed of about 15 turns, and not attached posteriorly. Muscular layers continuous, not separated into bands.

Considering the scanty material at my disposal and the smallness of the specimens, my description is very imperfect. I must therefore leave it undecided whether the species in question really is identical with *Phascolosoma minutum* KEFERSTEIN or with *Ph. sabellariæ* THÉEL — supposing that these two forms represent two distinct species — or with any other nearly related species. For my part I cannot present a single character distinguishing the specimens brought home from the Falkland Islands from e. g. *Phascolosoma sabellariæ* of the Swedish west-coast.

Phascolion strombi (MONT.) (?).

Pl. IV, figs. 50—66 and Pl. V, fig. 75.

Habitat. — Shag Rocks Bank between South Georgia and Falkland Islands: 53° 34′ S.—43° 23′ W., 160 m., sand and gravel, $^{19}/_4$ 1902. Several specimens.

The specimens from Shag Rocks Bank present such a puzzling resemblance to *Phascolion strombi* of our northern seas, that I am quite unable to demonstrate a single distinguishing character which would justify the foundation either of a new species or of a variety. The diversities are very insignificant indeed, and not greater than may be found in different specimens of the northern form.

Thus, e. g., the southern form has up to 30 tentacles (fig. 75) — in the northern form I counted from 16 to 26 —; its hooks, when such are present, seem to be slightly larger (fig. 53) and its horseshoe-shaped papillæ slightly more irregular (figs. 61—64). With regard to the whole organisation, I refer the reader to the figures 50—65 of this paper and to a former paper on the northern Sipunculids.[1]

---

[1] Kungl. Svenska Vetenskapsakademiens Handlingar. Bd. 39. Stockholm 1906.

Explanation of the Plates.

Plate I.

Figs. 1—5. **Priapulus caudatus** Lam. forma **tuberculato-spinosus** Baird.

Fig. 1. View of the dentary apparatus, the mouth and oesophagus having been opened along the dorsal surface. $^{20}/_{1}$.

V, ventral surface; 1—6, the six pentagons of teeth, the teeth of the first one being smallest; a—d, different views of teeth, as seen under a magnifying power of about 83 diameters.

» 2. Front view of the introvert with the mouth and teeth. $^{14}/_{1}$.

V, ventral surface; D, dorsal surface.

» 3. Ventral view of the foremost portion of the introvert. $^{8}/_{1}$.

» 4. Front view of the introvert with mouth and teeth. $^{4}/_{1}$.

V, ventral surface; D, dorsal surface.

» 5. Ventral view of the posterior extremity of the trunk with a part of the caudal appendage adhering. $^{3}/_{1}$.

The specimens illustrated in figs. 1—3 are from Graham Region, those illustrated in figs. 4—5 from Falkland Islands.

Figs. 6—11. **Priapulus caudatus** Lam.

(Spitzbergen: Treurenburg bay and Whales point.)

Fig. 6. View of the dentary apparatus, the mouth and oesophagus having been opened along the dorsal surface. $^{12}/_{1}$.

V, ventral surface; 1—7, the seven pentagons of teeth; a—d, different views of teeth from different regions of the oesophagus, as seen under a magnifying power of 50 diameters.

» 7. Front view of the introvert with mouth and teeth. $^{11}/_{1}$.

V, ventral surface; D, dorsal surface.

» 8. Ventral view of the foremost portion of the introvert. $^{8}/_{1}$.

» 9—11. Ventral views of the hindmost part of the trunk of three different individuals, $^{4}/_{1}$, $^{3}/_{1}$, $^{3}/_{1}$, showing the median ventral space devoid of warts.

Fig. 12. **Priapulus bicaudatus** Dan.

(E. of Greenland: 72° 25′ N.—17° 56′ W.)

Fig. 12. View of the dentary apparatus, the mouth and oesophagus having been opened along the dorsal surface. $^{12}/_{1}$.

V, ventral surface; 1—5, the five pentagons of teeth; a—d, different views of teeth from different regions of the oesophagus. $^{50}/_{1}$.

Plate II.

Figs. 13—19. **Priapulus horridus** n.

(Coast of Uruguay: 33° 0′ S.—51° 10′ W.)

Fig. 13. Ventral view of the animal. $^{20}/_{1}$.
» 14. Front view of the introvert. $^{20}/_{1}$.
V. ventral surface; D, dorsal surface.
» 15. A tooth broken off, probably from the interior of the oesophagus. $^{204}/_{1}$.
» 16. Four other teeth which also have become broken off and which must have been situated in front of the former. $^{204}/_{1}$.
» 17. Animal opened along the dorsal surface to show the internal structure. $^{31}/_{1}$.
ar, anterior short retractors; lr, posterior long retractors; lmb, longitudinal muscular bands of the skin of the introvert; n, nerve-cord; pr, posterior muscular bands of the body-wall; lgd, left genital duct; rgd, right genital duct; r, rectum; rp, respiratory lobes of the caudal appendage; d, diaphragmatic muscular membrane separating the cavity of the trunk from that of the caudal appendage, and having an opening for the rectum.
» 18. The caudal appendage with respiratory lobes and hooks. $^{80}/_{1}$.
» 19. Hind view of the posterior extremity of the caudal appendage. $^{80}/_{1}$.

Fig. 20. **Phascolosoma margaritaceum** (Sars).

(Falkland Islands: Port Louis.)

Fig. 20. The animal, natural size.

Figs. 21—23. **Phascolosoma ohlini** n.

(South Georgia: »Majviken».)

Fig. 21. The animal. $^{3}/_{1}$.
» 22. Part of the proboscis behind the tentacles. $^{120}/_{1}$.
» 23. Side-view of the foremost part of the proboscis showing the sparse hooks.

Plate III.

Figs. 24—27. **Phascolosoma ohlini** n.

Fig. 24. Sample of skin from about the middle of the body. $^{120}/_{1}$.
» 25. Posterior extremity of the body with its papillæ. $^{120}/_{1}$.
» 26. Sample of skin from the posterior extremity of the body. $^{120}/_{1}$.
» 27. Section through the skin from the posterior extremity of the body. $^{120}/_{1}$.

Figs. 28—34. **Phascolosoma anderssoni** n.

(Graham Region.)

Fig. 28. The animal, natural size.
» 29. Posterior part of the body. $^{5}/_{1}$.
» 30. Sample of skin from about the middle of the body. $^{78}/_{1}$.
» 31. Section of skin from about the middle of the body. $^{78}/_{1}$.
» 32. Posterior extremity of the caudal portion with papillæ. $^{78}/_{1}$.
» 33. Side view of bladders from the girdle. $^{78}/_{1}$.
» 34. Side view of papillæ immediately behind the girdle. $^{78}/_{1}$.

Figs. 35—41. **Phascolosoma nordenskjöldi** n.

(South Georgia and Falkland Islands.)

Fig. 35. The animal from South Georgia. $^{8}/_{1}$.
» 36. » » » Falkland Islands: Port William, having the proboscis withdrawn. $^{23}/_{1}$.
» 37. Anterior part of the proboscis with its two tentacular lobes. $^{12}/_{1}$.
» 38—39. Side views of the foremost part of the proboscis, showing the hooks. $^{120}/_{1}$.
» 40. Sample of skin from about the middle of the body. $^{120}/_{1}$.
» 41. Sample of skin from the posterior part of the body. $^{120}/_{1}$.

Figs. 42—45. **Phascolosoma minutum** KEFERSTEIN (?).

(Falkland Islands: Port William.)

Fig. 42. The animal. $^{16}/_{1}$.
» 43. » » with the proboscis withdrawn. $^{16}/_{1}$.
» 44. Front view of the proboscis. $^{70}/_{1}$.
» 45. Side view of the proboscis. $^{70}/_{1}$.

Plate IV.

Figs. 46—49. **Phascolosoma minutum** KEFERSTEIN (?).

Fig. 46. Side view of the skin from the proboscis. $^{160}/_{1}$.
» 47. Sample of skin from the posterior of the body. $^{56}/_{1}$.
» 48. Upper view of a glandular body with papilla from the posterior extremity. $^{350}/_{1}$.
» 49. Side view of such a papilla. $^{350}/_{1}$.

Figs. 50—66. **Phascolion strombi** (MONT.) (?).

(Shag Rocks Bank.)

Fig. 50. The animal having a part of the oesophagus turned out. $^{4}/_{1}$.
» 51. The terminal part of the proboscis of the same animal. $^{14}/_{1}$.
» 52. An animal cut open along the dorsal surface to show the internal structure. $^{6}/_{1}$.
a, anus; r, rectum with the diverticle; m, fixing muscles; dc, coils of the intestine running downwards; uc, coils of the intestine running upwards; n, nerve-cord; s, segmental organ; oe, oesophagus with its vessel; dr, dorsal retractor; vr, ventral retractors.
» 53. Different views of hooks. $^{240}/_{1}$.
» 54. Sample of skin with papillæ from the middle of the proboscis. $^{56}/_{1}$.
» 55. Side-view of the same. $^{56}/_{1}$.
» 56. Sample of skin on the transition from the trunk to the proboscis. $^{56}/_{1}$.
» 57. Sample of skin from the foremost part of the trunk. $^{56}/_{1}$.
» 58. Side-view of the same. $^{56}/_{1}$.
» 59. Sample of skin from the middle of the body. $^{56}/_{1}$.
» 60. Side-view of the same. $^{56}/_{1}$.
» 61. Sample of skin from the girdle of horseshoe-shaped papillæ. $^{56}/_{1}$.
» 62. The same of another specimen. $^{56}/_{1}$.
» 63—64. Side-views of the same samples of skin. $^{56}/_{1}$.
» 65. Sample of skin from the posterior extremity of the body. $^{56}/_{1}$.
» 66. Side-view of the same. $^{56}/_{1}$.

Plate V.

Figs. 67—68. **Phascolosoma margaritaceum** (SARS).

Fig. 67. Front view of the tentacular-crown. $^{18}/_{1}$.
D, dorsal surface with ciliated sense-pads; V, ventral surface.

Fig. 68. The body cut open to show the internal organisation. $^5/_1$.
oe, oesophagus with its vessel; dr, dorsal retractors; mm, mesentery; s, segmental organs; a, anus with muscles; fm, fixing muscles; dc, coils of the intestine running downwards; uc, coils of the intestine running upwards; vr, ventral retractors; g, genital glands; nc, nerve-cord.

Figs. 69—70. **Phascolosoma ohlini** n.

Fig. 69. Front view of the tentacular crown. $^{42}/_1$.
D, dorsal surface with ciliated sense-pads; V, ventral surface.
» 70. The body cut open to show the internal organisation. $^6/_1$.
oe, oesophagus; dc, coils of the intessine running downwards; uc, coils of the intestine running upwards; dr, dorsal retractors; vr, ventral retractors; a, anus; s, segmental organs; g, genital glands; nc, nerve-cord.

Figs. 71—74. **Phascolosoma anderssoni** n.

Fig. 71. The body cut open to show the internal organisation. $^2/_1$.
oe, oesophagus; dc, coils of the intestine running downwards; uc, coils of the intestine running upwards; dr, dorsal retractors; vr, ventral retractors; a, anus with its muscles; d, diverticle; s, segmental organs; g, genital glands; nc, nerve-cord; fm, fixing muscles; sm, spindle muscle.
» 72. Side view of the tentacular crown. $^{20}/_1$.
» 73. Dorsal view of the tentacular crown. $^{20}/_1$.
» 74. Front view of the tentacular crown. $^{20}/_1$.
V, ventral surface; D, dorsal surface.

Fig. 75. **Phascolion strombi** (Mont.) (?).

Fig. 75. Front view of the tentacular crown, the oral protrusion having been cut away.
V, ventral surface; D, dorsal surface.

Tryckt den 26 augusti 1911.

Uppsala 1911. Almqvist & Wiksells Boktryckeri-A.-B.